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Southern California Water Management: Practical Adoptions and Policy Recommendations

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Chapter 1- Introduction

Contrary to popular belief, the L.A. region is more of a desert than a tropical oasis. Little rainfall during the winter months and practically no rainfall during the summer months is characteristic of Southern California's desert-like weather patterns. Due to these low precipitation levels, water is considered the most important commodity in the Los Angeles region. Prior to 1900, the inhabitants of this area were fully aware of the importance of water. Most settlements were established near water sources and had adopted various techniques and constructed small-scale dams to conserve and reuse rainwater. Yet these measures were not sufficient to sustain large populations during drought conditions. Most settlers were forced to seek other areas where more reliable sources of water were found.

The construction of early engineering feats like the Los Angeles aqueduct quickly changed prior perceptions of the region's potential. Such systems allowed for cheap and previously inaccessible water to flow to the abundant land, spurring an unprecedented population and agricultural boom. For decades, the construction of more aqueducts and canals provided a sufficient amount of water to meet the demand in the region's growing agricultural and financial economy. As the abundance of land and favorable weather attracted more businesses and industries into the region, more and more homes were built to accommodate the workforce. By 1936, the Hoover Dam had been built and California had signed and agreed to the Colorado River Compact, which granted Southern California 4.4 million acre-feet annually of the Colorado River's water. As a result, relatively cheap water was able to meet the demands, thus catapulting California's agricultural industry and residential development.

Nonetheless, relentless demand for water out grew the relatively constant supply that was being provided by an elaborate water delivery system. In the 1970s, severe drought conditions slammed the LA region, exposing the region's insufficient water management system. In response, counties, cities and even the state mandated the adoption of drastic drought measures. Alternative methods, other than construction of more water conveyance systems, were seen as the best option to reduce the region's use of water. Counties and cities began to tap into local aquifers and issued water rationing. Yet intense residential development allowed for the continual floods of people into the land-abundant region, thus requiring these drought measures. Since then, local aquifers have been continuously tapped to supplement the limited water supply. An average of 30 percent of the aquifer's water capacity is being pumped out each year. During drought years, this percentage nearly doubles.[1]

To alleviate the demand, California's water utilities have spent and are currently spending millions of dollars in construction and attorney fees to import water from distant areas such at the Colorado River, the Sacramento-San Joaquin River Delta in the north, and deep-lying aquifers to supply businesses, farms and residential areas in the LA basin. Within 10 years, The Los Angeles County Waterworks has spent over $2 million in litigation charges alone.[2] Additionally, the Metropolitan Water District of Southern California spent more than $185 million over the past decade encouraging adoption of

[1] Rudd, Neis, Harter, Thomas, Naugle, Alex. "Estimation of groundwater pumping to the water balance of a semi-arid, irrigated agricultural basin." Department of Land, Air, & Water Resources, University of California, Davis. Journal of Hydrology, September 1, 2004, 51-73.

[2] Lee, Linda. "Adjudication annoys both sides: Water fight lasts for a decade," *Antelope Valley Press*, July 22, 2008, 1.

water efficient appliances and drought resistant landscaping.[3] These costs are surely to increase as demand increases and precipitation levels decrease. Today, residents average annual water bill is about $550[4]. It is expected that average water bills will go up as water utility companies begin to pass on their construction and legal debt to the end users.

It is also daunting the amount of continuous funding the State of California forks over to restore sensitive ecosystems that are continuously threatened by the lack of sufficient water due to appropriated water diversions. More than 22 percent of the state's remaining 122 native species of fish are threatened or endangered with another 45 percent imperiled or qualified for listing.[5] Currently, the State of California is in enormous debt and cannot continue to pay for these restoration efforts. Soon enough, these costs will be too great for the State to absorb and will be passed onto the end user, thus causing extreme spikes in annual water charges.

Another unfortunate fact is that much of this water is only used once before it is poured, flushed, and drained into rivers and streams that flow into the ocean. Another problem is that after we use this water it becomes saturated with harmful chemicals and organic waste that originates from our kitchens, bathrooms, lawns and streets posing the risk of contamination of both land and water. Positive measures by the state are taken to clean the water before it enters the ocean, yet the chemical and trash-carrying water is not

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[3] Hanak, Ellen, Lund, Jay, Dinar, Ariel, Gray, Brian, Howitt, Richard, Mount, Jeffrey, Moyle, Peter, and Thompson, Barton, "Myths of California Water- Implications and Reality," *West Northwest* 16 (2009), 17.

[4] "California Water Plan Update 2005. (2005), http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm. (accessed October 20, 2010).

[5] Hanak, Ellen, Lund, Jay, Dinar, Ariel, Gray, Brian, Howitt, Richard, Mount, Jeffrey, Moyle, Peter, and Thompson, Barton, "Myths of California Water- Implications and Reality," *West Northwest* 16 (2009), 8.

always completely cleaned. Frequently, the region's sanitation districts post contamination alerts to the coastal areas that neighbor river mouths and sewage outlets. To make the problem worse, wetlands and marshes that naturally act as a water filter have been destroyed and paved over for residential, commercial, and agricultural development. Consequently, the contaminated water ends up in recreational and residential coastal areas, causing dead zones, unhealthy algae booms and contaminated beaches.

In addition to our wasteful water habits, urban sprawl, characteristic of the LA region, has further attributed to this faulty system. Over decades, the construction of curbs, gutters, certain flood control systems, and impermeable roads have successfully pushed all the water off the land into the ocean as fast as possible. The consequence of such construction is that the natural water cycle is broken. The mismanagement of crucial rainwater that would be soaking back into vital aquifers and adding to the base flow of streams is not being effectively utilized. In addition, the concrete flood control systems that litter the LA region thwart the necessary deposit of mineral rich sediment from the headwaters to fertile valleys. Annually, millions of gallons of water that could either recharge aquifers or be effectively used for irrigation purposes are being drained straight into the ocean. A one-acre parking lot can produce 16 times more storm runoff than an acre meadow. Also, by not allowing the recharge of aquifers near coastal areas, aquifers are more susceptible to being contaminated by salt water and polluted urban runoff. If these aquifers become too contaminated, the water will be unsuitable for drinking or for many other purposes.

In terms of providing a constant, reliable and clean water source for decades to come, the Los Angeles metropolitan area is in serious trouble. Even though in the past century agriculture has been California's largest water user, California's population continues to increase, forcing opportunistic farmers to develop their land. It is expected that California's population will increase by 14 million (14 percent) from 2000 to 2030 while agriculture is expected to decline by only 5-10 percent by 2030.[6] This implies a 3.6 million acre-feet increase in water use to an already stressed system. The increase in urban demand adds tremendous demand to a system that is dependent on a relatively constant supply. Moreover, the reality of global climate change has become ever more apparent. Rising global temperatures, increasing severity of storms, shrinking of the arctic ice caps, decreasing rain fall, and more frequent droughts are all symptoms of the changing climate. All these signs point to an uncertain future for the majority of our fresh water supplies around the world and more importantly for this thesis, here in California.

Today, our current water management system is extremely flawed and will not be able to provide water to the millions of residents and businesses in the not-so-distant future. I will examine the current water management system that is being practiced in the LA basin area and determine key factors that can be addressed to improving the current system. Possible improvements include regional planning, grey water ordinances, hybrid pricing structure, education and incentive programs. Once the factors are determined, this thesis examines other cities and counties of other states that have already implemented water management practices to determine whether their practices can be employed in the

[6] "California Water Plan Update 2005. (2005), http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm. (accessed October 20, 2010).

Los Angeles basin and neighboring counties. The goal of the thesis will be to identify successful adaptations for the LA basin.

Chapter 2- Diagnosis of the Los Angeles Region

Population Growth

By 2030, Southern California expects to accommodate nearly half of the 14 million anticipated new California residents. These residents are expected to reside in the hotter, drier, and more desert-like inland areas of Southern California. The reason for the shift in the geographical distribution of Southern California's population growth can be attributed to the fact that these inland areas have the lowest land prices in Southern California. Studies performed by the Public Policy Institute of California shows that lower land prices are typically accompanied by larger lot sizes. In the Inland Empire, for example, average single-family lot sizes are about 10,000 square feet, compared to the Southern California Coastal areas like Orange County where lot sizes average about 8,500 square feet.[7] What makes this point relevant is that outdoor water use tends to rise as single-family lot sizes increase. Larger properties generally have larger yards that need more water. In Riverside County, officials estimated that 80 percent of residential water is used outdoors.[8]

In addition, these hotter, drier inland areas use more water for any given lot size due to evapotranspiration, the process by which water is lost to the atmosphere through evaporation from soil and plant surfaces and by transpiration from plants. In the Southern California coastal region, a square foot of cool-season grass will require 28 gallons of water or less per year. In the Inland Empire, that same square foot of grass will need 37

[7] Davis, Matthew, Hanak , Ellen. "Lawns and Water Demand in California." *California Economic Policy* 2, no. 2 (2006), 5.
[8] Ibid, 4.

gallons of water or more.[9] These differences are even more evident during the dry spring and summer months.

Climate Change

Coupled with the magnitude and projected geographical distribution of population growth in Southern California, the threat of climate change also complicates the mounting pressure to supply the region with a sufficient amount of water. An update to the 2005 *California Water Plan* identifies the potential risks of climate change on California's natural system. These include decrease in snowfall melt in the Sierra Nevada Mountains, more desertification in inland areas, more frequent and severe droughts, rising sea levels, increased extreme precipitation events, decreased groundwater recharge, degradation of water quality due to chemical runoff, and potential seawater intrusion in freshwater aquifers. All of these are dependent on the extent of greenhouse gas global atmospheric concentrations, how strongly features of climate respond to changes in greenhouse gas concentrations, and how much the climate varies as a result of natural influences and its internal variability.[10] The reality of climate change will greatly affect California's already stressed water delivery system and pose difficult decisions for California's political actors.

In 2000, the United States Geological Survey estimated California's public water supply at 6, 860 thousand acre-feet, based on withdrawals to users for residential, commercial, industrial, and thermoelectric-power purposes. Comparatively, the California Department of Water Resources (DWR) published a set of three scenarios that

[9] Davis, Matthews, Hanak , Ellen. "Lawns and Water Demand in California." *California Economic Policy* 2, no. 2 (2006) 6.
[10] "Future Climate Change." http://www.epa.gov/climatechange/science/futurecc.html (accessed November 21, 2010).

lay out California's water use projections for the next two decades. Based off of these three scenarios, the Pacific Institute estimated the urban water demand in 2030. The middle scenario, based on the current trend, points to 12 million acre-feet and incorporates the Intergovernmental Panel on Climate Change's middle projection of 1.0 to 1.7˚C increase per year, as observed from 1906-2005. The lower projection of 10 million acre-feet encompasses less severe climate change effects on the natural system while the higher projection of 14 million acre-feet considers more severe climate change effects. (Climate change assumptions account for most of the differences among the projections.) The likelihood and degree at which these scenarios may transpire is uncertain but all possibilities should be considered and accounted for.

What is known is that climate change will result in many financial, political, and societal burdens to millions of Californians. Today, Southern California relies heavily on seasonal snowpack melt in the Sierra Nevada Mountains. The current water delivery system efficiently captures this springtime snowmelt; however, climate change threatens to disrupt historical snowfall averages. Instead of snowfall, the Sierra Nevada Mountains may experience more rainfall, which the current water delivery system is not ideally designed to accommodate. These changes may make it more difficult to refill reservoirs during late spring and early summer months, potentially reducing the amount of water available during the dry summer months. In effect, lower reservoir levels impinge on lake recreation, hydroelectric power generation, and fish habitat. These sorts of reductions in the Sierra Nevada snowpack will require some adjustment in California's water systems and infrastructure to capture the difference in timing of precipitation and the greater

possibility of flooding. These adjustments will require millions of dollars of additional funding by a state government that is already strapped for money.

A change in the type of precipitation is not the only problem. Population growth in hotter geographical areas like the Inland Empire will exacerbate the water supply issue. To make it worse, computer-generated climate change scenarios indicate that areas that are currently hot and dry will become even hotter and drier as the climate shifts. As air temperatures increase, plant evapotranspiration increases, thus requiring more water to be imported from sources such as the Sierra Nevada Mountains.

Additionally, global climate change is related to rising sea levels. During the 20th century, sea levels rose by 0.2 meters and it has been predicted that a median rise of 0.5 meters will occur over the 21st century.[11] Increases in sea level presents an enormous threat to many of Southern California's water sources (i.e. groundwater aquifers). Currently, most Southern California water districts rely on groundwater to supplement their limited water supplies, but increases in sea levels can allow seawater to enter vital coastal aquifers. Once seawater enters these aquifers, the entire supply is ruined. The biggest threat of sea level increases could be in the Sacramento-San Joaquin River Delta. The probable rise in sea levels will put more pressure on critical levees that protect low-lying lands, leading to extreme seawater intrusion into fresh water sources that supply a substantial amount to Southern California.

More importantly, climate change studies show more frequent and severe droughts. These signs have become more aware over the years. In the past couple of decades, Southern California has experienced more droughts than ever before. The

[11] "Summary for Policymakers".

increased frequency of droughts greatly reduces water levels in reservoirs and reservoirs are unable to completely refill before the next drought occurrence. All of these consequences due to the change in Southern California's climate will force federal, regional, and local governments, water districts, and water companies to make tough and unconventional decisions to terms of water pricing and extending water supplies for the future.

Pricing

The Metropolitan Water District of Southern California (MWD) provides the water needs of nearly 19 million people in a 5,200 square-mile service area. Metropolitan's service area includes the counties of Los Angeles, Orange, San Diego, Riverside, San Bernardino and Ventura. Within these counties, Metropolitan consists of 26 member agencies including 14 cities, 11 municipal water districts and one county water authority, making it the largest water wholesaler in the country.

MWD imports its water from two sources: the Colorado River and the State Water Project (SWP). The Colorado River Aqueduct (CRA) begins at Lake Havasu and moves the water 242 miles west across the Southern Californian Mojave desert and mountains and into the Metropolitan's reservoirs located throughout the region. The State Water Project conveys water 444 miles from the Sacramento-San Joaquin Delta through the central part of the state, over the Tehachapi Mountains and flows into the Southern California coastal plain.

In a normal year, 1.5 billion gallons of water are delivered every day through its distribution system to its member agencies. Those agencies then sell that water to their own member agencies, or companies. The Metropolitan's regional distribution system

includes hundreds of miles of pipelines, power transmission lines, five water treatment plants, nine reservoirs, 16 hydroelectric plants, 45 pressure control structures, thousands of pumps and values, and hundreds of buildings.[12]

The maintenance and operation of such a complex and diverse regional distribution system is not an inexpensive venture. Metropolitan has adopted a complex pricing policy to obtain enough funds to maintain financial security and cover all of its capital, maintenance and operational costs. The prices each of its member agencies actually pays per acre-foot are not charged equal. Price differentiation exists because member agencies can choose to purchase treated or untreated water, each with a corresponding price. Also, certain member agencies are placed in a different tier with a different price. Tier 1 supply rate recovers the cost of maintaining and operating the existing amount of reliable water. Tier 2 supply rate is set at Metropolitan's cost of developing additional supply. A number of agencies may opt to pay these higher rates in the expectation that water will be guaranteed to them in the future. This is tantamount to purchasing water insurance. If there are water shortages, tier 2 agencies will receive all of their allotted water where tier 1 agencies will experience cutbacks.

Once a member agency is placed into either tier 1 or tier 2, additional fees are tacked on. A surcharge is added to each per acre-foot of water that is treated. The treatment surcharge allows Metropolitan to recover the costs of treating imported water. In addition, Metropolitan charges several other fees. The system access fee recovers a portion of the costs associated with the delivery of supplies. The system power fee

[12] "The Dream Comes True". MWD History. http://www.mwdh2o.com/mwdh2o/pages/about/about01.html (accessed November 18, 2010)

recovers Metropolitan's power costs for pumping supplies to Southern California and the water stewardship fee recovers Metropolitan's costs of financial commitment to conservation, water recycling, groundwater clean-up and other local resource management programs.[13]

Metropolitan also offers purchase orders to its member agencies. A purchase order is a ten-year contract that specifies an amount of water a member agency agrees to purchase. The incentive to agreeing to these contracts is that agencies can purchase their water at discounted prices. Today, 24 out of Metropolitan's 26 member agencies have executed purchase orders. Member agencies that choose not to agree to such contracts expose themselves to paying for the full price of their water and the risk of receiving no water if sanctions are administered.

Metropolitan also has special fees for different discretionary programs. A replenishment water fee for treated or untreated water allows agencies to purchase water at discounted prices to encourage groundwater replenishment. This fee was established in response to the concern over the quantity and quality of the water in local aquifers. In the past, local water districts and companies pumped out more water than nature was able to bring in. This practice of overdrafting makes the aquifers susceptible to seawater intrusion, potentially causing health hazards and possibility of collapsing. To prevent possible catastrophes, Metropolitan took action and created these reduced rates to motivate member agencies to replenish their groundwater sources. However, many water agencies have been known to use these reduced replenishment rates to supplement their

[13] "Water Rates and Charges". The Metropolitan Water District of Southern California. http://www.mwdh2o.com/mwdh2o/pages/finance/finance_03.html (accessed November 17, 2010)

water supply instead of replenishing the local aquifers. This illegal practice significantly reduces the price end users have to pay.

Metropolitan also offers reduced rates for agricultural users. Fifty years ago, a special low rate was established because many member agency leaders believed that agriculture played an important role in the growth of Southern California. And it was believed that for this growth to continue, agricultural users needed water supplied at a low price. Since then, Southern California has mostly moved away from agriculture yet a special low rate still exists, though only during times of surplus supplies. This agricultural program that Metropolitan offers causes domestic and municipal water users to pay higher rates in order to cover the capital and operating costs of delivery water to farmers.

In addition to revenue received from the sale of water to its member agencies, Metropolitan collects one percent of the property taxes that residents within the six counties pay. Originally, the income tax revenue helped Metropolitan pay back the Colorado River Aqueduct construction debts. Now that the aqueduct is in full operation, Metropolitan still insists that the revenue it receives from property taxes is a crucial source of revenue. This additional revenue is applied to the payment of its outstanding general bonds and a portion of its capital payments. In 2009, Metropolitan received $105,580 in tax revenues, $1,136,476 in operating revenues (i.e. water payments from their customers), against which it had $842,153 in operating expenses, and $226,059 in depreciation and amortization payments.[14] By continuing to receive property tax revenue, Metropolitan has subsequently been able to show a modest surplus, which allows it to

[14] The Metropolitan Water District of Southern California. “Comprehensive Annual Financial Report”. 2009, 17.

price its water lower than what it may actually cost. In addition, total costs of providing water (dam costs) are not reflected in the revenue and expense statement, reducing the pressure to price the water appropriately.

On the local level, these local water districts and companies sell their water to water utility companies that price the water in five different kinds of rate structures. These rate structures include flat, declining block, increasing block, uniform, and tier formulae. The most common rate structures that these companies employ today are uniform and increasing block, although tier pricing has gained some popularity. A uniform rate charges the same amount for every gallon of water used. Increasing block rates charge more per gallon for higher levels of use and the tier pricing structure charges a different rate depending on overall usage. The Irvine Ranch Water District is an example of a water district that employs the tier pricing structure. The Irvine Ranch Water District has established four different tiers: low volume discount, conservation base rate, inefficient, excessive, and wasteful. Each tier ranges by hundred cubic feet (HCF)[15] and is accompanied by a corresponding rate, adjusted for by several factors including: landscape area, number of residents, weather and evapotranspiration. The theory behind this method is that wasteful users will be more inclined to adjust their habits and that the block method does not provide sufficient incentive. Also, the tiered water pricing structure "avoids the regressive nature of higher base rates."[16] Since implementation of the tiered billing structure in 1991, Irvine Ranch Water District residents have decreased water usage by approximately 15 percent despite its structural

[15] 1 HCF= 748 gallons
[16] "Comparison of Irvine Ranch Water District's Single Family Residence Rate Structure to the City of San Diego's", 3.

unfairness to customers who lie on the cusp of each tier.[17] However, not all companies choose to use these rate structures. Flat rate structures still exist especially in the Central Valley, more notably the City of Fresno. By not employing an increasing block rate or tier pricing structure, water users do not realize the true societal price of water and are less likely to spend money on water conservation technology and techniques.

The Los Angeles Department of Water and Power (LADWP) is another major supplier of water to the Los Angeles basin. In 1905, William Mulholland, superintendent and chief engineer of LADWP, became aware that Southern California's local water sources (Los Angeles River and deep-lying aquifers) would not be able to sustain the region's rapid population growth. To resolve this problem, Mulholland "looked north" to the Eastern Sierra Mountains to augment the region's limited water supply. After eight years of construction and millions of dollars in bond issuances, water began gushing down into the Los Angeles basin via the 233-mile long Los Angeles Aqueduct. This additional water supply would be sufficient enough until 1970 when the LADWP decided that an additional aqueduct would be required. The 177-mile long peripheral aqueduct had the capacity to increase LADWP system's annual flow to 152,000 acre-feet and meet the water demands of the Southland's residents and businesses. (This figure depends on the winter's snowfall and varies from year to year.) In 2008, the Sierra Nevada Mountains received below historical average snowfall, providing LADWP with only 18 percent of its water. In order to meet demands of its 720,000 customers in the cities of Los Angeles, Bishop, Culver Cuty, South Pasadena, and West Hollywood, LADWP was

[17] Ibid, 1.

forced to purchase water from Metropolitan, approximately 71 percent.[18] Local groundwater sources and recycled water provided the remaining 11 percent.

Water in California is a scarce and precious resource yet the price of using water in many areas does not convey that sort of message to its end users. In actuality, the way water is priced by Metropolitan and similar water districts creates the illusion of limitless water supplies. In order for Metropolitan and other water districts to price according to the true societal value of water, they must adopt a more equitable pricing policy that reflects the full costs of securing and delivering water. Currently, Metropolitan's standard pricing policy disproportionately charges more to local water districts that purchase a small portion of water. This unfair pricing creates somewhat of a subsidy for other local water districts that purchase a large portion of Metropolitan's water because the delivery costs are being passed on. These practices are a couple of examples the way water districts, companies and cities have been employing to ensure a cheap, reliable, and constant flow of water to its end users. Most of all, the access to the Colorado River water at virtually no cost allows water wholesalers to illegally overdraw California's allotted amount outlined in the Colorado River Compact of 1922 and supported in the 1963 *Arizona vs. California* ruling.

Today population and energy demand is growing in all of the western states that are Colorado River water rights holders and they are beginning to withdraw their entitled allotment. This is squeezing California's current water supplies. It is up to California to adapt to a lesser supply of water with a growing population. The most obvious solution is to extend the existing water sources, although that is easier said then done. Water

[18] "LADWP Quick Facts and Figures".
http://www.ladwp.com/ladwp/cms/ladwp000509.jsp (accessed October 29, 2010)

wholesalers, their member agencies, and local agencies are in the business of providing water to its users and they all need to make enough revenue to cover their capital, maintenance and operational costs. This reality undermines the conservation efforts that these agencies promote. Conservation programs cannot be too successful or the water delivery infrastructure will deteriorate due to lack of funds. More importantly, the threat of climate change worsens the situation. The current water infrastructure is designed for our historical climate. Future scenarios point to less snowfall and more rain fall in which our current infrastructure is designed to catch. This uncertainty will dramatically affect the lives of millions of people who rely on the seasonal runoff of snowmelt and cost billions are dollars in order to adjust.

Chapter 3- Practical adoptions and Policy Recommendations

In a draft economic report released to the California Legislature on August 25, 2009, Steven Kasower of the Strategic Economic Applications Company estimated that the cost of constructing a peripheral canal around the California Delta or tunnel under the estuary to augment the water supply flowing to Southern California would range from $23 billion to $53.8 billion, depending on the conveyance option.[19] Financing such a monumental project would increase the California debt from $1.5 billion to $3.4 billion annually.[20] Subsequently, the cost of water conveyed by this project would be significantly higher then the costs of what water users currently pay. With such a high price tag, the State of California and the federal government cannot afford to finance this type of project.

In addition, fishing and environmental groups have opposed the peripheral canal or tunnel proposal because of the negative environmental damages associated with the construction, as well as the uncertain effects of diverting more water away from the critical delta habitat of many federally listed endangered species, including the Delta smelt. To make it worse, a clash of interests between urban users, certain industries, and the environment still exists. This longstanding political conflict has hindered the cooperative efforts that have been attempted among these parties.

Since infrastructural changes to supply the growing water demands of society are not feasible, changes will have to occur through technological innovations, reformed governmental and industrial policies, and adjustment in society's perception in regard to

[19] Kasower, Steven. "An Exploration of Costs, Examination of Assumptions, and Identification of Benefits". The Sacramento San Joaquin Delta. 2009, 2.
[20] Ibid, 2.

water usage and availability. Full cost pricing mechanisms and non-pricing conservation programs seem to remain the only financially and politically realistic options for meeting the growing demands. According to data gathered from Seattle's "1%" water conservation program implemented in 2006, non-pricing conservation programs proved to be less costly then developing most traditional, new sources of water supply. These conservation programs can be implemented quickly, without the need for permits, approvals or revisions, and avoid high litigation costs.[21] This saves time, energy and costs for the water agencies while still achieving the same results as constructing a new dam. In order for such conservation programs to be successful, a solid planning and collaborative effort by all stakeholders will be required by the urban, industrial, and environmental sectors, with the main objective of extending California's current water supply and providing a sustainable local water supply for future growth.

Universal adoption of a highly detailed conservation plan on the water district or agency level is the first crucial step. Incorporated in this plan should be studies and information that provide a deeper understanding of the natural interactive processes. Provided with such knowledge, an effective, regional conservation plan will offer Southern California future sustainable sources of water, protect groundwater aquifers, and ensure the survival of critical ecosystems. A key aspect to the success of such a plan is an unwavering commitment by every player who provides water to millions of residents and businesses within the region. A multi-agency, collaborative, detailed and binding plan will guarantee the continued success of the Southern California billion dollar economy and account for the uncertainty of the future.

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[21] "Seattle Water Supply System. Regional 1% Water Conservation Program". 2006 Annual Report. August 2007.

Although 80 percent of California's water use comes from the agricultural sector and given the political realities of the strength of the farmer's lobby, realistically, the urban sector is capable of providing the majority of water-use reductions. The best policy approach is a combination of conservation and pricing reform. An urban-focused, non-pricing conservation program is the less politically controversial water conservation option, and is cost-effective.[22] In addition, full cost water pricing mechanisms would yield the greatest decrease in water use across all sectors.

Non-pricing conservation programs can be focused on three areas in the urban sector. Improvements in indoor water efficiencies, cutbacks in outdoor use, and increased awareness from all of the stakeholders through educational programs have the potential for greater and more efficient use of the current water supply. Future water demands can be met through the coordinated use of the local water supply (i.e. groundwater and surface water) as well as greater use of reclaimed water in irrigation. These reliable and cost-effective improvements will be essential for Southern California to keep up with demand, preserve more water for aquatic life, recreation, water quality and other important purposes, and account for the uncertainty of climate change.

Urban water conservation can be achieved by encouraging the desired behavior through incentive programs, awareness programs, and regulation reform. First, by offering incentives, water users will be financially motivated to pursue water-saving technologies and practices. Examples of the incentive program are water-wise technology rebates, water-efficient device giveaways, and irrigation upgrade and landscape

[22] Cooley,Heather, Christian-Smith, Juliet, Glieck, Peter, Cohen, Michael, Heberger, Matthew. *California's Next Million Acre-Feet: Saving Water, Energy, and Money.* Oakland: Pacific Institute , 2010.

conversion reimbursements. These kinds of incentive programs will encourage water users to use less water even if water rates are not higher.

An example of a water district that is actively pursuing this type of program is Tucson Water. Currently, Tucson Water offers a wide array of rebates for the latest water-saving technologies. Residential water users in Tucson can receive a $200 reimbursement when a permanent gray water irrigation system is installed in their homes. This simple renovation has the capacity of saving a typical household 13,000 gallons of potable water a year, which translates into a significant amount of financial savings.[23] Another rebate that is available to commercial and multifamily facilities that use inefficient irrigation systems and are seeking to upgrade their systems to become more water efficient. The intention of these rebate programs is to help save water and money for the water user as well as the water utility company.

Evidence gathered from the Evaluation and Cost Benefit Analysis of Municipal Water Conservation Programs (ECoBA) project that analyzed a total of 88 separate cases from 42 different programs offered by 30 utilities companies across the United States presents some profound findings in regard to effectiveness of non-pricing conservation programs. After nine years, the ECoBA project found that the most significant savings per participant were from the toilet distribution programs (27,000 gallons annually) followed by the landscape conversion program (22,000 gallons annually). The lowest cost to save an acre-foot of water was the toilet distribution program.

A broad range of options is available for water utility companies to pass on relevant information about non-pricing water conservation programs to various

[23] "Gray Water Ordinance". Planning and Development Services Department. http://cms3.tucsonaz.gov/water/ordinances

audiences. Water utility companies might want to contract experts in marketing and communications, although cost of contracting must be weighed against the potential benefits. A combination of different approaches with respect to print and media coverage has proven to be effective in disseminating information to various audiences.

Second, in terms of awareness, Southern California urban water customers can become aware of the current unsustainable trends of water use through a statewide educational program. This educational program would be geared to illustrate the degree of water issues in California, the available options to address these water-related issues, and the costs and positive externalities associated with adopting water-wise practices and technologies. Online tutorials, brochures, advertisement, and monthly workshops are some examples of how a program could allow urban users to stay up-to-date on the status of water consumption in Southern California and the new methods to conserve water.

Monthly workshops would provide hands-on teaching for the do-it-yourself type of homeowners, which would allow them retrofit their home by themselves and save a considerable amount of money on installation costs. Brochures attached to the monthly water bill and available at local stores and restaurants would be a constant reminder to customers of the available incentives being offered by the Southern California water coalition. Also, these brochures could offer coupons to water-wise businesses (i.e. car wash), conservation tips, and information on current water measures for greater public participation.

Development of other avenues of communication would also be beneficial. For example, gardening magazines and websites could print and post new landscape conservation alternatives and customer gardening successes. Avid gardeners could be

knowledgeable of the latest water-saving measures and pursue landscape conversion incentives. This mass media information program would provide customers the necessary education to forgo their under-informed water-use habits, learn the ways to extend the current water supply, and begin to make a difference in urban water use in their community.

In addition, these types of programs would be available to the industrial sector with industry-specific recommendations. The best method for the industrial sector to gain water efficiencies would be to educate business owners about ways to contact federal and state government to provide incentives that facilitate proper adoption of otherwise overly-expensive, new equipment. Although the solutions to the industrial sector are far more complicated, any step in a more sustainable direction will help.

An example of an industrial-focused conversation program is the Water-smart business program currently utilized by Tucson Water. This program offers a menu of incentives for businesses to save money as well as conserve water. Businesses that decide to participate is this program first must arrange for an analyst from their local water utility company to evaluate all of their indoor and outdoor water uses, identify areas in which conservation methods (i.e. xeriscape landscaping, low flow toilets, etc.) can be applied, and develop a water management plan. Upon thorough inspection of the property, the analyst will provide the business a cost/benefit analysis. Entailed in this analysis is a list of available incentive-based programs that the water company provides, accompanied by a comparison of projected water use costs per year to the amount of money saved per device. The cost of the device would also be included in the analysis. A key component of the program is the water management plan that decreases water

allotments for the property on a regular basis. To encourage wide adoption of this program, the water utility company offers participants higher reimbursement amounts on available incentive-based programs. Other benefits include public recognition, networking opportunities, discounts, and priority standing for water allocations in case of future water restrictions.

Another component to the success of these incentive and awareness programs is keeping the customer service staff well-informed on the range of programs being offered. By being thoroughly knowledgeable of all the programs, customer service employees answer various questions and/or refer concerned customers to the proper individuals who can help with the particular issue. Regular communication from the conservation department to customer service is key.

Whereas these awareness and incentive programs hold some promise, limitations to these types of conservation strategies are present. The maintenance and promotion of these types of programs generate high fixed costs to the water utility company. The majority of this cost is spent on the continuous training of customer service representatives and the consistent flow of information through the company's various communication avenues (i.e. brochures, advertisement and workshops). For the water utility company to exhibit a strong commitment to reducing the community's water usage, consistent communication is essential, because the company needs to ensure that customers will not become disillusioned when demand is not high and supply is abundant.

An important risk to the program is the timing and content of a program. Certain incentive programs offered during tough economic times might not be as effective as

types of awareness programs. An awareness program may be the best approach at the time to educate customers until customer's disposable income returns. Once customers can afford to invest in conservation programs, they will have the necessary knowledge to take advantage of the various incentive programs being offered. In addition, more awareness and incentive programs should be offered during drought years. A heavier push during these times may yield the best results because people are increasingly aware of the water conditions.

Third, pricing reforms combined with the above conservation programs would be the best approach to achieving decreased water usage and accounting for the uncertain future. A full cost pricing structure would convey the notion of water conservation through higher bills for wasting water. Such pricing reform would include adoption of a new hybrid pricing structure to encourage conservation and discourage water waste. In 1991, Irvine Ranch Water District implemented a tiered billing structure and they observed a 15 percent decrease in water usage while landscape area doubled in size. Customers of Irvine Ranch Water District are given proper water allocation amounts based on several factors including landscape footage, number of residents for multi-family dwellings, indoor water uses, and regional evapotranspiration rates.[24] An allocation equation takes these variables and determines per property hundred cubic feet water budgets.[25] These conservation-based water budgets are strictly enforced and if customers use more than their allotment, rates per hundred cubic feet increase substantially. (See IRWD table). The hybrid pricing structure is based on this pricing

[24] "Comparison of Irvine Ranch Water District's Single Family Residence Rate Structure to the City of San Diego's", 3.
[25] Ibid, 3.

methodology. Instead of a uniform increase in water rates at every tier, the hybrid model would increase at a higher rate for all water used over and above the conservation allotment. By employing this structure, the customer will more strongly feel the effects of heavy water overuse and pursue conservation measures. To be in compliance with AB 2882 amendment of California Water Code, this type of structure must be based on metered water use, which means all municipalities would have to install meters to all water users before implementing this rate structure.

In addition, this new hybrid, tiered rate structure can be accompanied by technology that adjusts the base allocation and water rates of each tier depending on daily factors including amount of rainfall, soil moisture and cloud coverage. If any of these factors is present on any given day, the rates will adjust accordingly. Initially, this technology-based rate structure will be introduction on the municipal level and eventually required for all new residential and industrial development. Subsidies will be offered to lower the price tag of the device to an affordable level.

A device currently available on the market is a wireless sensor that prevents automatic sprinkler systems from watering when rain has fallen, or moisture is present. Orbit Professional offers this device for $50. The Orbit wireless rain sensor transmits a wireless signal to the receiver that is connected to the resident's sprinkler system timer. When a user-specified amount of rain has fallen or amount of moisture is present, the sensor will alert the sprinkler system and turn off until the conditions change. The Orbit wireless rain sensor can be easily attached to most sprinkler systems, allowing for installation ease and wide adoption.

For new residential and commercial developments, the wireless rain sensor can be coupled with an advanced sprinkler system that connects to the Internet via wifi. The system's wireless sensor will transmit the precipitation and weather information to the on-site sprinkler system then the sprinkler system will convey that information to the water utility company's central computer. Rate adjustments can be made based off of the current weather conditions being recorded on-site and water users will be notified via email or phone about rate changes while the sprinkler system performs the necessary adjustments. Many major institutions in Los Angeles, such as UCLA, have installed a similar system. ET Water offers this type of advanced system for $300 plus installation. Residential adoption of this advanced system can be offered through local water utility company rebate programs and device give-a-ways.

Accompanying these pricing and conservation methods, city-wide adoption of new plumbing codes that require water-efficient fixtures in all new residential and commercial construction should be signed into law as well. Ultra low-flow toilets that use 1.6 gallons or less per flush, shower heads and faucets that do not exceed 2.5 gallons per minute. These codes would apply to the replacement of plumbing fixtures in renovation projects for residential and commercial buildings.

To remain active and enforceable in the future, these water conservation strategies need to be represented in law or regulation. Initially, these types of ordinances can be passed on the municipal level for political feasibility reasons. As more political support is gained and the severity of the issue penetrates the entire state, statewide adoption will guarantee compliance and success. On October 14, 2008, the City of Tucson signed an ordinance requiring all new commercial construction to incorporate rainwater-harvesting

technology. The ordinance requires that 50 percent of the business's landscape needs be supplemented with harvested rainwater. Passage of ordinances such as this reinforces that conservation programs persist into the uncertain future.

Another type of ordinance is a grey water ordinance that requires installation of plumbing for grey water distribution in all new single-family homes, duplexes, and multi-family dwellings. Individual residential use of a gray water distribution ordinance can save nearly 13,000 gallons of potable water a year.[26] A xeriscape landscape ordinance applied to new multi-family, municipal and industrial development could bring substantial water savings as well as aesthetic beauty to a city. To be in compliance with the xeriscape landscape ordinance, businesses, municipalities and multi-family developments would be required to design landscape areas to take full advantage of storm water runoff from buildings while featuring drought-tolerant plants throughout the landscape. Owners would have an option of different types of drought-tolerant plants that they could choose from. A complete list of plant options would be available on the city's website. Landscape designs will be required to only use drought-tolerant landscape practices. Included in the ordinance would be limitations on the size and location of non-drought-tolerant vegetation based on landscape use.

The recommended policy and practical water-saving adoptions have the potential to save considerable amounts of both water and money while enabling demand to be met without the construction of new, ecologically-damaging conveyance structures. In order for such changes to be applied, water customers need to be fully informed of the types of changes necessary to achieve the city's objectives and have unanimous agreement that

[26] Gray Water Ordinance". Planning and Development Services Department. http://cms3.tucsonaz.gov/water/ordinances

the problem exists. This requires people to be involved throughout the entire process through public scoping meetings, ubiquitous information and customer service representatives. Realistically, everyone will not be in favor of all of the proposed ideas because each embodies varying ideologies. Some may get a sense of government controlling their lives and telling them how to manage their water. Others may object to the redesigned rate structure that heavily punishes overuse. Gradualism is a possible solution to many of the objections raised by the public.

Chapter 4- Examination of Relevant Case Studies

Tucson, Arizona

The city of Tucson is located in Southern Arizona where the northern part of one of the driest and hottest deserts in North America, the Sonoran Desert, reaches. On average, Tucson receives 11 inches annually during three distinct seasons. The summer months, June to September, is monsoon season when intense thunderstorms roll into the region bringing the majority of annual rainfall. From October to November, occasional Pacific storms will drop a significant portion of the yearly average. While the months of December to March, are characterized by slow-moving storm fronts and less rainfall of the three.[27] Despite these three seasons, Tucson is frequently subject to droughts and infrequent weather patterns, which poses an enormous threat to the region's one million residents. Since its foundation in 1850, the city of Tucson and surrounding areas have experienced double digit, even triple digit, growth per decade, which is not expected to cease in the future. With such a large current population and the expectation of future growth, Tucson Water, the region's water provider, has employed several methods to address some of the most pertinent issues of water quality and quantity.

Most of the water Tucson uses is pumped from its 212 production wells that tap into many of the basin's aquifers and is stored in 65 different storage facilities around the region.[28] Since the 1960s, Tucson pumps water at rates exceeding the natural recharge rates, which have the potential for devastating consequences. In response to the accelerating depletion of groundwater levels of the region, the city of Tucson sought

[27] Taylor,T, Goldstein, R. *Sustainable Water Resource Management, Volume 3: Case Studies on New Water Paradigm.* Palo Alto: Tetra Tech, 2009, 6.
[28] Ibid, 6.

alternatives to supplement its limited water supply. As its principle alternative, Tucson has established a vast reclaimed water system that contains over 160 miles of pipeline, five reservoirs, and a ten-million-gallon-per-day filtration plant. Originally adopted in 1975 for irrigation purposes of the city's golf courses, the network, has expanded immensely. Currently, Tucson's reclamation water program supplements the water needs of 820 sites, including 18 golf courses, 47 parks, 61 schools, and 704 single-family residences.[29] The reclaimed water system delivers over 14,000 acre-feet of water to these users, whom would have otherwise used potable water sources.[30] This water is also used to aid in riparian restoration efforts and aquifer recharge measures.

As defined by the Arizona Department of Environmental Quality, Tucson water delivers Class A reclaimed water. That is, this water is safe enough to be used for watering edible vegetables, vineyards, and orchards, non-residential toilets, fire suppression, and livestock watering as well as various public facilities such as schools and parks.[31] Over its 26-year history, there have been no reported cases of illness caused from reclaimed water usage. The utility's ultimate goal is provide Class A+ reclaimed water to its customers. This will require an upgrade of the wastewater treatment plants to achieve the standard of 10 mg/l or less of total nitrogen concentration.

The development of the Tucson Water Regional Reclaimed Water System has allowed industries such as the region's premier destination golf industry to flourish,

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[29] Taylor,T, Goldstein, R. *Sustainable Water Resource Management, Volume 3: Case Studies on New Water Paradigm.* Palo Alto: Tetra Tech, 2009, 6.
[30] Thomure, Tim, Kmiec, John. "The Importance of the Tucson Water Regional Reclaimed Water System to the Economic Vitality of the City of Tucson-Pima County Region". 2008, 5.
[31] "Reclaimed Water Quality". http://cms3.tucsonaz.gov/water/recl_wq (accessed March 30, 2011)

providing economic opportunities for the community and establishing an "anchor" for expansion of the system to meet the water needs of municipality facilities and the rapid-growing residential sector. Inevitably the system will continue to grow, collecting more wastewater to be filtered and pumping into the region's water supply. This method is integral to the city's future because as the population increases the region's water supply will grow. In addition, Tucson's reclaimed water system provides an excellent case study for which other cities and regions can adopt to meet their future water needs.

Prior to 1993, groundwater pumping was Tucson's principal method of quenching the region's water needs. From then until now, Tucson supplements its water by utilizing another major provider of water to the area, the Central Arizona Project (CAP). Approval and passage of the CAP lasted for over 22 years until 1968 when President Lyndon B. Johnson signed a bill allocating the necessary funds to begin construction. After decades of litigation, 20 years of construction and $4 billion dollars in funding, Arizona was finally receiving their original allocation of water (2.8 million acre-feet) from the Colorado River as agreed upon in the Colorado River Compact of 1922. Once water began flowing 336 miles from Lake Havasu to Tucson, Tucsonans decided to limit CAP water usage for only aquifer recharging measures, due to the apparent odor and discoloration.

In regard to the pricing of water, Tucson is on the forefront of true cost pricing. All customers are subject to an increasing block rate structure for potable water and a flat rate structure for reclaimed water. To make reclaimed water attractive to customers, Tucson has kept the reclaimed water rates lower than the potable rates. This involves

subsidizing costs associated to reclaimed water, which varies from year to year. Even so, the subsidy for fiscal 2011 is only 3 percent.[32]

Tucson's current rate structure is comprised of numerous charges including a monthly base service charge, a usage charge, a CAP charge, and a conservation charge.[33] The monthly base service charge captures the costs of meter maintenance and replacement as well as meter reading and billing costs. A usage charge is calculated per residential customer based on an increasing block rate structure. This structure increases the unit price of water as the customer moves up each usage block. For other potable water customers except multifamily, mobile home parks, and construction water customers, a year round base rate is charged. During the summer months, these customers will be subject to summer surcharges if their monthly summer water usage exceeds their average monthly winter usage. (Summer months are May through October). A second summer surcharge is applied to these customers when summer usage is 145 percent above the customer's average monthly winter water usage. Multifamily, mobile home parks, and construction water customers are charged a higher monthly year round rate without summer surcharges. Revenues recovered by the CAP charge are used to pay for the city's allocation of CAP water. The conservation charge is applied to all potable water users, which allows Tucson Water to recover funds for their conservation efforts.

For the customers who are connected to the Tucson Water Regional Reclaimed Water System, two different charges are levied: a monthly service charge and a usage charge. The monthly service charge is the amount a customer pays regardless of water

[32] Ibid.
[33] Tucson Water. "Current Water Rate Schedules". http://cms3.tucsonaz.gov/water/rates (accessed April 3, 2011).

usage, which depends on the size of the meter (i.e., the diameter of the pipe). The size of the meter ranges from 5/8 of an inch to 12 inches and corresponds with rates of $5.87 and $694.93, respectively.[34] Unlike the increasing block rate structure faced by users of potable water, the reclaimed water users face a single rate. By means of subsidization, the rate is set lower than the potable water rates at $1.83, thus providing incentives for large-volume water users to integrate into the citywide system.[35] (See graph: Tucson Water).

In light of much uncertainty regarding a sufficient and sustainable water supply for the region, Tucson Mayor Bob Walkup and the Pima County Board of Supervisors in April of 2008 commenced a multiyear, interagency, comprehensive study for the development of a sustainable water resource plan, known as the City/County Water and Wastewater Infrastructure, Supply and Planning Study.[36] This study is a joint effort between the various agencies within the City of Tucson and Pima County to organize a more cooperative and sustainable water regional plan. To pursue such an audacious examination, the study has been split up into various phases with varying timelines. A 12-member oversight committee, the Regional Water Study Oversight Committee, was assembled to control the first two phases of data collection and analysis. As instructed by the Mayor and Council, the oversight committee must actively engage the community throughout the entire process. The ultimate goal of this study is to assure a sustainable water source given the uncertain future of population growth, climate change and the city's aging water infrastructure.

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[34] Tucson Water. "Current Water Rate Schedules". http://cms3.tucsonaz.gov/water/rates (accessed April 3, 2011).
[35] Ibid.
[36] Water and Wastewater Infrastructure, Supply and Planning Study. http://www.tucsonpimawaterstudy.com/ (accessed April 6, 2011).

Phase I of the study examined and assessed three main objectives and formulated recommendations to address these objectives. The committee's first objective was to complete a comprehensive inventory and analysis of the region's current water condition and capacity, wastewater and reclaimed water infrastructure, and the ability of the existing infrastructure to sustain the current population and account for future population growth. The second objective was to estimate the current and future population that the current, known water sources can be sustained without the addition of new sources and no significant change in conservation. The third was to find ways to improve communication and coordination between Tucson Water and the Regional Wastewater Reclamation Department.[37] The accomplishment of these objectives provided the goals of cooperative water and water reclamation planning, water supply improvement, and the additional reclaimed water sources to conserve groundwater and CAP water.

By agreement of numerous policy issues and commonly held values, Phase II establishes a common set of water resource development and conservation goals between the City and County. Both entities agree upon land-use regulation to steer the location of future population growth and expansion of water-using facilities, and the water infrastructure to accompany this growth. Due to the confined nature of the regional reclamation water system, the Committee also addressed the financial and institutional constraints that hinder the maximum use of reclaimed water within the city limits as well as the surrounding area. The phase II report focuses on the development of new, renewable water supplies, a drought management plan, and water conservation

[37] Water and Wastewater Infrastructure, Supply and Planning Study. "Updated Scope of Work: Water Infrastructure, Supply and Planning Study". www.tucsonpimawaterstudy.com/PDF/updatedscope4-1-08.pdf (accessed April 8, 2011)

ordinances that protect future water supply. An overarching objective of this phase is to acknowledge that the environment is a consumer of water and requires a fair share of water in order to provide the community a vibrant and healthy atmosphere. Although the deadline to Phase II was July of 2009, the Committee did not fully complete the phase until December 2009.

In addition to the coordination and investigation of a regional water infrastructural plan and the implementation of a regional water reclamation system, Tucson has fostered the adoption of multiple small-scale, incentive-based methods for water conservation. The City of Tucson was one of the first cities in the nation to pass such measures for increased urban water conservation. Some examples include tax credits for installation of rainwater and gray water harvesting systems (residential and commercial), rebates for installation of a residential gray water irrigation system and replacement of toilets and urinals with high efficiency models, and promotion of a WaterSmart Business program.

Residential customers who install a permanent gray water irrigation system are given a reimbursement of $200.[38] A gray water system gathers the wastewater from sinks, showers, bathtubs, and washing machines, and filters it in order to be used to irrigate fruit trees, landscapes and lawns. An on-site gray water irrigation system is attractive to both the water utility company and the homeowner. For the homeowner, the system significantly reduces water use and costs. For the utility company, it allows gray water to be integrated into the property without requiring invasive and drastic construction to pipe the regional reclamation water system near the property. To make sure that these customers are knowledgeable about their new system, Tucson Water has

[38] Tucson Water. "Water Saving Rebate Programs". http://cms3.tucsonaz.gov/water/rebate (accessed April 8, 2011)

several 2-hour workshops available to aid in the design, operation and maintenance of an appropriate gray water system.

Effective from 2006 until 2012, the State of Arizona offers residential customers a 25 percent credit of system costs up to $1000 for installation of a rainwater and grey water harvesting system.[39] In addition, a corporate credit of $200 is provided for a plumbing stub out (i.e. a separate plumbing system that can be connected to future fixtures to collect all gray water sources).[40]

As one can see, Tucson's regional planning, reclamation system, and conservation programs are ahead of the game in regard to ensuring a sufficient supply for future generations. Water providers in Los Angeles should take note of the progressive steps that are being applied in Tucson and decide whether the same methods can be administered. If Los Angeles continues to rely on historical approaches to preserving water sources to the region, there will not be enough water to supply a growing population and hedge for climate change.

Las Vegas, Nevada

Another important and relevant city of the arid west is Las Vegas. What makes Las Vegas of particular relevance is that it is located in the middle of the Mojave Desert. Due to its geographic location, Las Vegas records only about four and half inches of rainfall annually, considerably lower than both Los Angeles and Tucson. The majority of the precipitation (about two inches) falls during the winter months from December to March. Although March is typically the wettest month of the year, it only receives three

[39] Tucson Water. "Water Saving Rebate Programs". http://cms3.tucsonaz.gov/water/rebate (accessed April 9, 2011).
[40] Ibid.

more days of rain than the driest month of the year.[41] Las Vegas is constantly battered with multi-year droughts, which has detrimental effects on the two million residents of Clark County. Similar to other major cities of the west, greater Las Vegas has grown tremendously since its inception, posting double and triple digit growth rates per decade. Although growth to the region has recently subsided, primarily due to the economic downturn, it is expected that Las Vegas will return to its historic growth rates, further exacerbating its current water supply problem. Because water is such a scarce resource and the high probability of soaring population growth in the near future, the Southern Nevada Water Authority (SNWA), the region's seven-member cooperative agency, has developed specific measures to address southern Nevada's water needs.

Las Vegas receives water from two main sources: the Colorado River and the hundreds of groundwater wells scattered throughout the region. Ninety percent of the city's water needs are from the Colorado River; and ten percent from pumped groundwater. Under the Law of the River[42], the entire state of Nevada is allocated 300,000 acre-feet. This figure was authorized with the passage of the 1928 Boulder Canyon Project Act. Originally, the 300,000 acre-foot allocation was thought to be more than sufficient to sustain the population, and it was not until 1950 when Nevada began using its Colorado River water allocation. Yet, this additional supply quickly proved to be insufficient, as population of the region exploded, especially during the recent housing boom. In response to the limited amount of water supply, Las Vegas was forced to find alternatives to increase its supply.

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[41] National Oceanic and Atmospheric Administration. "NCDC US Climate Normals".
[42] The Law of the River refers to numerous federal laws, compacts, court decisions, and regulatory guidelines that allocate the water of the Colorado River among seven states in the west.

Some of the alternatives Southern Nevada Water Authority has utilized resemble many of the strategies that other major western water utility providers have put into practice. Similar to Tucson Water practices, SNWA offers a comprehensive, region-wide rebate coupon program that gives reimbursements for adoption of water-saving products. This rebate program differs with respect to what types of water-saving products are pre-approved under the rebate program. For example, a single-family, residential property owner receives a $50 rebate or 50 percent off the purchase price, whichever less, for pool covers. If the residential owner prefers to install a permanent, mechanical pool cover, a $200 rebate or 50 percent off the purchase price, whichever less, can be obtained. This fairly cheap, simple solution can yield considerable reductions in water evaporation, 10,000 to 15,000 gallons of water saved each year.[43]

Another distinctive water-saving product that is available under SNWA's rebate program is an instant coupon for a rain sensor. The rain sensor coupon provides $25 or 50 percent off the purchase price of a qualifying product, whichever is less.[44] Installation of a rain sensor on a residential irrigation system can potentially save 500 gallons a day, because a residential landscape does not require watering after a heavy episode of rainfall. In addition, SNWA offers a $200 or 50 percent off the purchase price of a qualifying product for a smart irrigation controller.[45] This smart irrigation controller automatically adjusts watering schedules based on the local weather conditions. SNWA recommends that this product be installed and set up by a professional, due to the high

[43] Southern Nevada Water Authority. "Pools and Spas". http://www.snwa.com/html/cons_pools.html (accessed April 15, 2011).
[44] Southern Nevada Water Authority. "Rain Sensor Instant Rebate Program". http://www.snwa.com/html/cons_coupons_rainsensor.html (accessed April 15, 2011).
[45] Southern Nevada Water Authority. "Smart Irrigation Controller Rebate Coupon". http://www.snwa.com/html/cons_coupons_smartclock.html (accessed April 15, 2011).

degree of knowledge required to properly adjust watering schedules for different plants, soil content, landscape design and other factors.

Like Tucson Water, SNWA recognizes that a significant amount of water savings can occur by offering financial incentives to commercial and multifamily property owners who install water-efficient devices. If such property owners decide to implement water-efficient technologies from the menu of pre-approved water-saving technologies, a cash refund is available. Examples of the types of water-efficient technologies are high efficiency toilets, efficient showerheads, waterless or high efficiency urinals, and conversion of a grass sports field to an artificial turf. Though these programs are quite similar, one distinctive aspect characteristic to SNWA is the availability of incentives for any custom technology that meets the business needs as well as meets the prerequisites as a water-efficient device. Consumptive-use technologies earn up to 50 percent of the product purchase price or $25 cash refund for every 1,000 gallons saved each year.[46] Non-consumptive use technologies earn up to 50 percent of the product purchase price or $8 for every 1,000 gallons of water conserved each year.[47] It has been estimated that this program has saved nearly 2.8 billion gallons of water since its adoption in 2001.

A SNWA program that Tucson Water has not considered is the creation of the Water Upon Request program to serve water only upon request. This program is in collaboration with the Nevada Restaurant Association that allows participating restaurants to receive free menu stickers that indicate whether the restaurant supports water conservation this way. This program saves as much as 3 gallons of water for every

[46] Southern Nevada Water Authority. "Water Efficient Technologies". http://www.snwa.com/html/cons_wet.html (accessed April 15, 2011).
[47] Ibid.

glass of water not served as well as time and money. Already 180 restaurants around the Las Vegas region have enrolled in this program.

As Las Vegas is the "entertainment capital of the world" and annually hosts about 37 million visitors a year, Southern Nevada Water Authority has facilitated a rather common linen exchange program for the hundreds of local hotels and resorts. The hotels and resorts that opt into the program agree that linen will not be changed every day, unless upon request by the guest. Instead, linens and towels are changed once every three days during a guest's stay. There is a considerable amount of benefits for participating hotels and resorts. These include 50 gallons of conserved water per room each day, as much as 30 percent reduction is laundry costs, and at least a $1 reduction in operating costs per occupied room each day.[48]

SNWA most of its emphasis and energy into is its Water Smart Landscape Rebate program. This program provides rebates for owners who decide to convert their water-intensive grass to a desert landscape. Each square foot of grass removed and replaced up to the first 5,000 square feet per property per year is reimbursed $1.50. Beyond the 5,000 square foot threshold, the rebate is reduced to $1 per square foot. The maximum payment for any property is set at $300,000. For every square foot of grass replaced saves on average 55 gallons of water annually.[49] Since its implementation, the program has already saved billions of gallons of water and helped the community upgrade more than 150 million square feet of grass. To aid the customer, the SNWA

[48] Southern Nevada Water Authority. "Linen Exchange Program". http://www.snwa.com/html/cons_biz_linen.html (accessed April 16, 2011).
[49] Southern Nevada Water Authority. "Water Smart Landscapes Rebate". http://www.snwa.com/html/cons_wsl.html (accessed April 16, 2011).

website provides free landscape designs as well as a list of Water Smart contractors to contact.

Another important aspect of SNWA's commitment to water conservation in the Las Vegas region is the focus on enforcement of water waste. On a regular basis, SNWA's member agency investigators patrol their service area to identify customers who are not adhering to the strict conservation ordinances. If water waste is observed on a property, the investigator documents the water waste and notifies the property owner. Watering running off the property into the gutter is considered a waste of water and requires an immediate remedy. Depending on the water waste action, the owner can have as little as 48 hours to fix the problem before a fine is assessed. If violations continue, the amount that is levied rises. The goal of enforcement is not to harass an owner about an offense but to educate them and demonstrate that water is an important and valuable resource. Besides enforcement by investigators, SNWA encourages residents to report water waste violations that occur in their neighborhood. These reports can be submitted via the Internet or over the phone. Free water waste classes are offered throughout the year for water waste violators. These classes help property owners identify and correct water waste of their property. First violator fees can be rebated if they chose to attend this class.

The Las Vegas region has seen a sharp decrease in the amount of water waste over the years due to effective programs like the SNWA's Water Smart Landscape Rebate program, watering restrictions, and water waste enforcement. Adoption of such practices by water providers in the Los Angeles region would yield considerable reductions in water use. Similarly, communication and education of the types of

incentive-based programs that are available will remind people of the money that can save as well as the water that can be conserved. Reductions in water use would allow more water to be used for riparian restoration efforts as well as discourage construction of more water conveyance infrastructure.

Both Tucson and Las Vegas present great examples of the kinds of measures that are successful to providing a sufficient amount of water to a large metropolitan population while conserving the most precious and vital resource of the arid west. The Los Angeles region must seek similar methods if it going to provide enough water to its growing population and to account for the effects of climate change.

Chapter 5- Conclusion

Because of the growing vulnerabilities of providing a sufficient water supply in Southern California, increases in water supply will have to occur through an urban water conservation approach. An effective urban water conservation strategy can be achieved by encouraging the desired behavior through incentive programs, awareness programs, and regulation reform. Water reforms tested by other cities offer a great example of many successful water conservation strategies, and ought to be seriously considered in the Los Angeles basin.

Full cost pricing mechanisms and non-pricing conservation programs are the most financially and politically realistic options. As evident from my examination of the cities of Tucson and Las Vegas, full cost water pricing mechanisms yield the potentially greatest decrease in water use across all sectors. Customers who are subject to an increasing block rate structure for potable water realize the true societal cost of providing water to a semi-arid region. Overconsumption results in steep monthly bills, which conveys to these customers that this sort of behavior is undesired. In turn, such customers will decrease their unsustainable actions, and seek ways to conserve water and save money, a win-win for both the customer and the water utility company.

Together with this full cost pricing structures, application of a flat rate structure for reclaimed water, as seen by in the Tucson case study, is another way to reduce customer's use of imported water, and encourages customers to integrate into a regional system. The more customers that are integrated into the system the more the local water supply grows. Before a flat reclaimed water structure can be applied to the Los Angeles region, a region-wide commitment to the construction of such a system is the first step.

Once agreement has been met and the system expands, customers will have the opportunity to hook into the system and benefit from it at a significantly reduced price. To ensure the system continues to grow, city-building codes must be altered so new residential building will have a separate gray water system as well as reimbursements for gray water system installation.

Coupled with the pricing mechanisms, water utilities need to implement incentive-based water conservation programs. Such programs allow customers who are eager to conserve water and money to take advantage of the opportunities to save money on water-efficient devices while decreasing water usage. This directly promotes the desired, water-saving behavior that water providers are hoping for. Both Las Vegas and Tucson offer a menu of incentive-based conservation program. One program, in particular, offered by Southern Nevada Water Authority that should be applied to the LA basin is the Water Smart Landscape Rebate program. The best part of these conservation programs is that they can be implemented quickly, without the need for permits, approvals or revisions, and avoid high litigation costs. This saves time, energy and costs for the water agencies while still achieving the same results as constructing a new dam.

The third aspect to an effective urban water conservation strategy is awareness of the current water situation and the potential water insufficiencies. Through the use of online tutorials, brochures, advertisement, monthly workshops, and similar approaches, the region-wide educational program will foster the necessary awareness for the region's population to educate themselves and pursue water conservation initiatives. Although it is understood that some customers will ignore these educational methods, enforcement of the city's conservation ordinances make for certain that everyone is complying as well as

inform violators of incentive programs. Water providers in the LA basin should emulate the enforcement practices employed by many Las Vegas water utility companies. In addition, water utility companies can raise some funds from non-compliance violations to help offset the costs of the incentive programs.

Most importantly, solid planning and collaborative efforts by all stakeholders and agencies should be emphasized. The City of Tucson presents that best paradigm of the sort of regional planning that is needed for the LA basin to be successful. A multi-agency, collaborative, detailed and binding plan will guarantee that all water providers within the basin will actively strive to achieve significant reductions in current water use. The regional plan will also guide present city and county officials to continue the success of the Southern California billion-dollar economy and account for the uncertainty of the future. Without such a highly detailed plan, conservation efforts may turn out to be futile and produce inefficient results. Also, the regional plan ensures that the efforts of today will be persist into the future.

To account for the vulnerabilities that face the millions of residents in the Los Angeles basin, cities, counties, and water utilities must campaign to providing a local water supply. In other words, the region has to look for holistic solutions, solutions that will allow enough water to flow to one of the most important regions of the United States for decades to come. This means analyzing water management success stories from the around the world, and deciding whether any of the methods used in these locations can be adopted to fit the Los Angeles model. In essence, the Los Angeles basin necessitates reliable and cost-effective strategies to keep up with demand, preserve more water for

aquatic life, recreation, water quality and other important purposes, and account for the uncertainty of climate change.

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